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Original Research Article

Healthcare workers in Saudi Arabia perceive stress differently according to gender but not in cortisol levels: an immunoassay study

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ABSTRACT

Background: Working in the healthcare sector is generally regarded as stress inductive, which hampers performance, yet one demanding constant accuracy. This dichotomy has led to numerous investigations on the impact from perceived stress on hospital workers but focused primarily on employing psychological methods to determine perceived stress. This study sought to employ an arguably more objective measure of chronic stress on female healthcare professionals in Saudi Arabia, by assaying the concentration of hair cortisol (HCC) in parallel with stress questionnaires.
Methods: Pharmacists, nurses and lab workers participated in providing hair samples. Cortisol levels were subsequently quantified using immunoassay methods. Investigations considered the variables of age, gender, and smoking, hair coloring or bleaching or working in shifts on both stress perception and HCC.
Results: On average chronic stress was perceived comparably between the different healthcare professions and not differ significantly against the female control group. However, chronic stress differed significantly between genders within the healthcare profession. In contrast, HCC levels showed no direct relation to stress perception with respect to either gender or profession. HCC did, however, show steady decreases with respect to age, as an indirect measure of experience, that contrasted against the identical scores for stress perception. Finally, night shifts, smoking or hair colouring did not produce a significant change on HCC in the healthcare cohorts.
Conclusions: Women in the healthcare profession perceive stress higher irrespective of profession compared to men. Also show a pattern of decreasing levels of cortisol with increasing age despite reporting similar stress perception against younger participants.

Keywords: Cortisol, Stress, Enzyme-linked immunosorbent assay, Healthcare, Hair

INTRODUCTION

Workplace stressors have been known for some time to be the main triggers of human stress, with detrimental effects such as being linked to cardiovascular diseases or leading to emotional/attention problems (as reviewed lately).[1-3] In addition, it was more recently reported that this hazard is not only greater during night duties but also that the level of duty load correlates with blood pressure and autonomic nervous system activity in a dose-dependent manner.[4] Unsurprisingly, findings such as these inevitably led to follow-on investigations intended at identifying the causes that can trigger stress, such as family-work conflicts, or the different behavioural outcomes manifested in healthcare workers when considering that such professionals cannot afford near misses or medication errors, as reviewed for

pharmacists.[5-7] Curiously, though, these studies pose the question as to whether these preliminary conclusions are universal. To that end, we sought to conduct a similar pilot investigation on healthcare professionals in the eastern region of Saudi Arabia (KSA), with the view of assessing to what extent this particular community compares with these reported findings.

Quantifying stress, however, is understandably challenging given the topics stated above, so our study opted for a two-pronged approach consisting of assaying cortisol levels deposited in hair in combination with the more traditionally employed questionnaires. Our reasoning was to evolve from simple survey-based studies such as those conducted among hospital workers that relied on questionnaires and identifying self-reported stress alone.[8,9] These are arguably subjective, given to susceptibility such as that from reporting bias or immediate emotional state. Measuring stress by measuring hair cortisol concentration (HCC), on the other hand, is a more reliable method to determine the extent to which workers are stressed, for the hair root is nourished by circulating blood and hence serum cortisol levels can be detected in the hair shaft.[10] HCC also offers the opportunity to observe the levels of this compound over a significant period of time (assuming an approximate hair growth rate of 1 cm per month, a hair strand of 3 cm long provides a timeline of 3 months), which translates to the opportunity of assessing chronic stress. In addition, hair samples are not reliant on the diurnal cortisol cycle, unlike other methods of cortisol sampling such as serum, urine or saliva. Finally, the acquisition of hair samples is comparatively less invasive, non- painful, and samples do not requires specialized storage conditions, such as refrigeration.[11] The only recognized study about measuring stress through HCC in healthcare workers revealed no significant difference in both hair cortisol or perceived stress when compared to librarians.[12] Yet, this study did not consider other variables that might affect HCC readings such as gender, smoking or chemical treatment of hair, including dying.[13-15]

This study hypothesizes that stress is perceived differently between healthcare professions versus controls and that this event is affected by supplementary factors such as gender. Moreover, that HCC continues to provide an objective quantitative measure of chronic stress that can serve as baseline data for future studies looking at lessening the maladaptive consequences from chronic stress, such as worsening cognitive performance.

METHODS

Cohort of interest and study paradigm

This article disseminates the findings from a master's programme provided by the University of Brighton undertaken by the second author over the period between September 2017 and September 2018. Said study enrolled 54 participants from a number of hospitals and healthcare settings at the eastern province of KSA. Participation was inclusive to either gender or marital status, aged between 20 and 50 and accepted regular smokers, as well as individuals that used hair colouring products. The chosen cohorts of interest were female healthcare workers, defined as those whose job entails facing patients-nursing (Nur), pharmacy (Pharm) or laboratory technicians (Lab)- versus female non-patient facing workers, included as controls for the purpose of investigating the effect of profession, as well as male healthcare workers to investigate the effect of gender. Exclusion criteria in turn prevented participation by individuals who were pregnant, reported taking steroids, and reported suffering from significant mental health conditions, such as generalised anxiety disorder, or chronic morbidities within three months prior to study participation. Participants that met the inclusion criteria and disposition to take part in the study were asked to provide consent 'a priori'.

The study paradigm comprised of obtaining initial demographic information, proceeded by completing the Cohen Perceived Stress Scale and finally to provide a hair sample for the purpose of assaying cortisol levels.[16] This latter model has become well established as an efficient and quick indicator of chronic stress, as reviewed by Russell's group.[10]

The Cohen perceived stress scale-10

The perceived stress scale (PSS)-10 is a commonly employed human factor measure that provides information on the participants reported perceived stress or, as originally termed by its author: 'a measure of the degree to which situations in one's life are appraised as stressful'. The 10 items that comprise each questionnaire are scored using the commonly employed 5-point Likert scale (0– never to 4– very often). We followed the previously described two-factor structure that classifies positively worded items (4, 5, 7 and 8) into what the authors define as the 'perceived self-efficacy factor', while negatively worded items (1-3, 6, 9 and 10) are grouped into the 'perceived helplessness factor'.[17] This two-factor model is reputed to fit the data better compared to the unidimensional model which considers all 10 items together (for a more in depth analysis read Taylor JM).[18] Also, the scores for the positively worded items were reversed prior to analysis, as recommended in the original article, then the final score from the 10 items that comprise each questionnaire were evaluated according to the three degrees of perceived stress commonly recognized: scores of 0-13 are considered low stress, those between 14-26 are considered moderate stress while the range between 27-40 are considered high perceived stress.[19]

Cortisol analysis from hair samples

This study elected to investigate the history of stress in participants by assaying cortisol levels accumulated in

hair. This analysis model has become well established as an efficient and quick indicator of chronic stress, as reviewed by Russell and colleagues.[10] Participants were requested to provide a 3 cm segment of hair extracted from the posterior vertex area and immediately adjacent to the scalp as this provides a three month history of cortisol that can be investigated alongside reported stress. Following processing as described by Davenport's group[20], the assay buffers containing cortisol were analysed using ELISA immunoassay (Enzo life science cortisol kit), with a calculated inter-assay coefficient of 4.08% and intra-assay coefficient of 3.2%.

Data reliability and statistical analysis

All of the data and statistical analysis was conducted using Excel version 16.22 or Graphpad Prism Software version 8. We investigated in the first instance the distribution of perceived stress scores with respect to either gender or profession using the Shapiro-Wilk normality test (with threshold set at $p<0.05$). Data from the PSS was then tested for consistency using the Cronbach's alpha coefficients followed by the chi-square test to test goodness of fit. Both tests were conducted for the perceived self-efficacy and helplessness factors but also on the 10-items as a whole for the sake of interest. Values for alpha above 0.65 for the Cronbach test or p values below 0.05 for the goodness of fit test were indicative of consistent and reliable data.

Between group comparisons for PSS scores or HCC levels with respect to gender, night duty shifts, hair colouring or smoking status was carried out using either one-way ANOVA or Krustal-Wallis based on the outcome of the normality analysis. For PSS or HCC comparisons with respect to age, however, participants were first categorized into 3 main groups- 21-30, 31-40 and 41-50 years old – prior to statistical analysis.

Finally, this study also investigated for any correlation between PSS scores and HCC levels using the non-parametric Spearman test.

RESULTS

Demographics

A grand total of 54 participants enrolled in this study. However, the dataset from two participants (a pharmacist and a nurse) was discarded due to an inability to provide a sufficiently long hair sample. The demographics and particular features are summarised below (Table 1).

PSS two-factor reliability and chi-square analysis

The output from both the Cronbach's alpha coefficient and goodness of fit tests confirmed that the data were both reliable and fit the model. Those of particular mention are the results for the female healthcare workers, which ranged between 0.713 to 0.828 for the perceived helplessness factor and between 0.728 to 0.775 for the perceived self-efficacy factor. The corresponding figures for the female non-healthcare workers came at 0.677 and 0.699, respectively (Table 2).

Table 1: Demographic and participant features.

	N	%
Gender		
Female or male	39/13	75/25
Healthcare profession (female/male)		
Lab; Pharm; Nur	8;10;11/7;5;1	
Controls (female only)	10	
Age group (years) (female or male)		
21-30	17/12	
31-40	18/1	
41-50	4/0	
Shifts (female or male)[a]	16/9	41/69
Married (female or male) [a]	22/4	56/30
Serious event (female or male)[a]	9/6	23/46
Hair colouring (female or male)[a]	20/0	52/0

[a]n: number and percentage are relative to the total number making each gender group.

Perceived stress and hair cortisol

The PSS scores were normally distributed between all professional healthcare datasets, as well as the female non-healthcare controls (Shapiro-Wilk test, data not shown). The same analysis, though, revealed mixed results for cortisol levels, with the male technicians and pharmacists passing the normality test but none of the female healthcare professions.

The averages for the reported PSS scores obtained for the female participants was fairly similar between the different healthcare professions, which did not differ significantly when compared to the female control group (Table 3). There was, however, a significant difference in stress perception when analysing these same cohorts against the same professions in the male cohort ($F_{(6,45)}=2.58$, $p=0.031$, one-way ANOVA; Table 3). In addition, this gender-specific difference became more

apparent when comparing PSS scores between the two cohorts after removing the profession variable (p=0.0085, Student T-test; Figure 1). Analysis of HCC levels, in turn revealed no interaction between either profession or between gender (p=0.735, Krustal-Wallis; data not shown). Equally, the correlation analysis did not yield a direct link between PSS and HCC in any of the cohorts tested (data not shown).

Table 2: Summary of PSS scores plus output from the reliability analysis.

Profession	Cronbach's alpha	Chi-squared test (p value)	10-item analysis	Cronbach's alpha Chi-square (p value)
4 item*			Female lab	0.793 (0.003)
Female lab	0.775	0.008	Female pharm	0.835 (<0.001)
Female pharm	0.733	<0.001	Female nurse	0.674 (<0.001)
Female nur	0.728	<0.001	Female controls	0.685 (<0.001)
6 item**			Male healthcare	0.853 (<0.001)
Female lab	0.821	0.012		
Female pharm	0.731	<0.001		
Female nur	0.828	<0.001		
Female controls				
4 item	0.699	<0.001		
6 item	0.677	<0.001		
Male healthcare***				
4 item	0.902	0.015		
6 item	0.828	<0.001		

*perceived self-efficacy factor, comprising the positively worded items (4, 5, 7 and 8), **perceived helplessness factor, comprising the positively worded items (1-3, 6, 9 and 10), ***'Male healthcare' denotes the grouping of all male participants from the three healthcare professions.

Table 3: Summary of PSS and HCC scores by profession and gender.

Profession	PSS	HCC
	Mean (SD)	Mean (SD)
Female lab	21.5 (5.1)	7.78 (9.6)
Female pharm	21.8 (5.9)	6.16 (4.7)
Female nurses	22.5 (4.9)	6.77 (5.4)
Female controls	18.8 (4.2)	4.13 (3.4)
Male lab	15.6 (8.1)	5.27 (4.7)
Male pharm	13.0 (6.6)	6.08 (3.5)
Male nurses	18.0 (0)	11.94 (0)
Male healthcare*	14.8 (7.1)	6.09 (4.3)

*'Male healthcare' denotes the grouping of all male participants from the three healthcare professions.

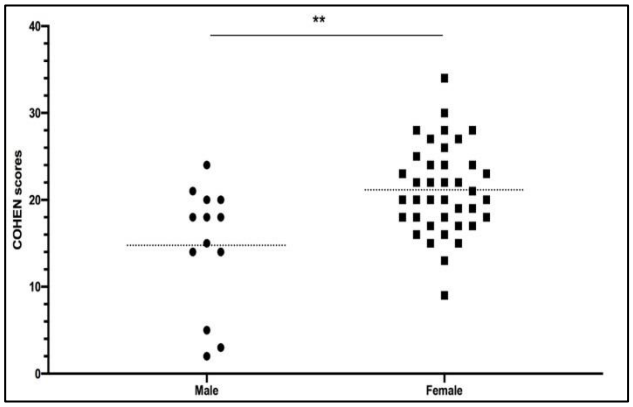

Figure 1: PSS scores between genders.
Dashed line denotes mean. ** p <0.01 (student t-test).

Effect of age

Presented with the above outcome, this study decided next to investigate if PSS and HCC scores for the female participants differed with age, as an indirect measure of experience. Results showed that PSS scores did not change significantly between the three groups [mean (SD)]: 22.6 (5.3) for the 21-30 age group, 19.9 (5.1) for the 31-40 age group and 21.3 (0.9) for the 41-50 age group (p=0.37, Krustal-Wallis; Figure 2). By contrast, HCC scores did indeed decrease significantly with age: 7.5 (4.6), 5.6 (7.2) and 2.8 (1), respectively (p=0.02, Krustal-Wallis; Figure 2).

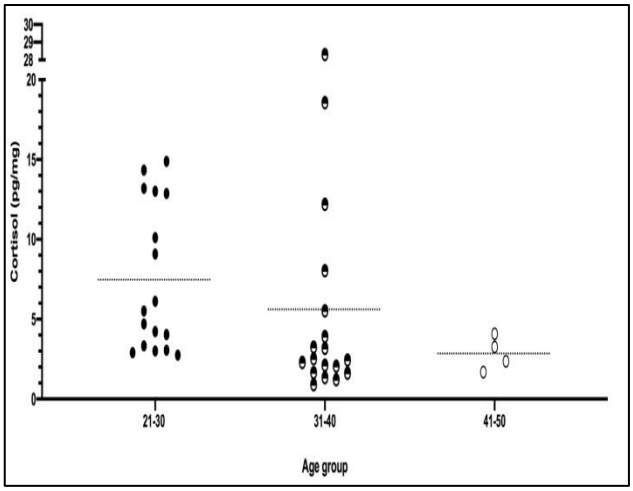

Figure 2: HCC scores by age group.
Dashed line denotes mean.

Effect of shifts, smoking, prior trauma or hair colouring

This study also considered if night duties (shifts), smoking or hair dyes could have a potential impact on PSS and HCC scores independently of profession. Statistical analysis, however, did not uncover any incidence whereby any of these variables had a significant effect on either PSS or HCC (data not shown).

DISCUSSION

The purpose of this study was to conduct a pilot investigation to assess if the sampling of cortisol levels deposited on hair could provide an effectual, minimally-invasive model of objectively assessing chronic stress on multiple healthcare professions in the eastern region of KSA. In addition, we wished to investigate how these measures correlated with perceived stress, documented through one of the more universally accepted questionnaires employed in assessing this condition. Moreover, this study also considered several variables known to affect an individual's perceived generalised stress, such as employment status or smoking.[14]

The sparsity of studies employing this double-approach methodology presented us with an initial challenge: that of basing our findings from the healthcare workers against a local reference range. The study therefore examined, in the first instance, the range obtained from the control group compared to the literature. Our analysis revealed values in the 1.62-13.2 pg/mg range, which is lower than previously identified levels with means ranging between 11 and 18 pg/mg.[21,22] However, although all sampled groups from this study also came below these averages, as shown in Table 3, the values do not differ greatly to these published references.

One of the more evident findings from our analysis was an observable difference in PSS scores between genders, whereby the male cohort scored significantly lower than females, despite the latter including the female controls that in itself reported lower stress compared to the healthcare professionals (Table 3). This reaffirms previous accounts from a quantitative review that report females as being more likely to experience stress and anxiety, following trauma or posttraumatic stress disorder, compared to men.[23] Indeed, gender bias is raised as a significant issue in studies that employ the PSS-10 questionnaire, whereby females generally report higher levels of stress.[24] Moreover, sex hormones as well as hormonal status are identified as the predominant motive behind this gender-specific divergent response to stressful events.[25]

When considering the female cohort alone, our analysis also revealed that stress perception was higher for all of the healthcare professions when compared to the control group, albeit not reaching significance. One possible justification for this outcome could be the wide range of scores, resulting in large standard deviations. Such contrasting scores are witnessed too in studies combining the Cohen questionnaire with assaying of hair cortisol, with scores ranging between 2 and 33.[12,26] Such discrepancies could explain the decision by other investigators to assess PSS using alternate questionnaires, such as the Effort-reward imbalance or the trier inventory of chronic stress scale.[8,9,14,22] Nonetheless, the Cohen questionnaire remains as the universally preferred choice to assess PSS and our results indicate that all of the cohort groups, including controls, report experiencing moderate stress which may be simply indicative of the general pattern of work-related stress. Interestingly, the PSS from all our cohorts do indeed range closer to the scores obtained in a study comparing stress levels between employed (18±6) versus unemployed (26±6) using this questionnaire.[27] Of note is that this same group also reported that HCC correlated positively with employment status. We did not observe such a contrast between the healthcare professional versus controls, with only very modest differences between these cohorts. However, methodological differences regarding what are considered a control group between our study and this published evidence should be considered. For example, the negative controls in our study are more closely matched to the healthcare cohorts in that all are employed, with the only variable being the nature of profession. At the same time there are numerous investigations into the effects of specific diseases that either report a lack of a gender-related variation in HCC or this compound being lower in women with advancing age compared to men.[14,15,21] On the opposite side of the scale, there is a recent upsurge in publications identifying gender-differences in perceived stress leading to the development of psychological maladies such as exhaustion that affects women to a greater extent, as exemplified for hospital staff.[28] These and similar investigations could explain the discrepancy between a gender-related significant difference in the PSS that was not equally observed for the HCC in our study. One suggested mechanism behind this difference is that stressors produce a higher hypothalamic-pituitary-adrenal response in men compared to women.[29] The type of stressor has also an impact on this gender-difference. Male subjects, for example, show a significant increase in salivary cortisol in response to achievement challenges (math and verbal challenges) versus females that responded higher to social rejection challenges.[30] Ultimately, our work and the literature provide evidence that any research intended on improving well-being, or providing staff satisfaction must consider gender differences to both the class of stressors as well as the behaviour output, and clearly avoid grouping individuals from both genders.

In addition to gender, this study also wished to answer if age, as an indirect measure of experience (since this study did not record each participant's length of employment), influences how stress is perceived/reported in KSA healthcare workers. This analysis revealed that while PSS did not differ significantly between the age groups, HCC

did, showing a steady decrease with age. While this was only a preliminary finding given the limited scale of this study, one possible explanation for this HCC trend is provided in a recent study whereby HCC was higher in individuals that fall in the high over commitment (ERI model) category.[31] These are characterized by high effort, low reward and high over commitment, which is generally associated with a younger age group. Curiously, there remains a misconception that older individuals are more likely to experience higher stress from taking on roles with greater responsibilities. Yet, the evidence indicates otherwise, whereby age was observed to have no impact on how an individual adapts to cope with stress.[32] It is possible that this behavioural outcome stems from a decrease of cortisol, although only a study specifically investigating for mechanisms between coping mechanisms over the period of an individual's adult life could provide this answer.

The final questions this study addressed was to investigate if night shifts, smoking or hair colouring could have an effect on both PSS and HCC on KSA healthcare professionals as acknowledged in the literature.[14,33,34] Of these, the former was hypothesized to have the most significant impact based on previous findings that report higher HCC in individuals working in shifts, in particular to younger individuals.[35] We did not observe the same significant effect, but this could be accounted by this study employing a considerably smaller number of participants undergoing shifts (n=14) versus the published reference (n=33), or differences in the preparation and extraction of cortisol. Nonetheless, working in shifts is demonstrably linked to ill health due to its effect on HPA axis and circadian de-synchrony.[34] Consequently, any future studies seeking to explore HCC as a means of assessing chronic stress on healthcare professionals, in particular if these involve shifts, definitely needs to consider segregating the study participants accordingly.

Conversely, while the lack of a significant impact from smoking on either PSS or HCC in our cohort of choice does accord with some articles in the literature, others have observed a positive association and advocate that smoking should be taken in consideration in future research.[11,13,14] There is the general concept that smoking can be a stress reliever, which may indicate an effect from nicotine on cortisol release.[36] The crucial question to resolve, however, is the mechanism whereby nicotine increases cortisol incorporation to the hair, which remains unclear.

Given that this investigation comprised the work for a Master's degree there were a number of provisions that limited its scope, which included difficulties in obtaining hair samples from male participants, in particular due to baldness, fewer numbers of older participants that are more likely to suffer stress as a result of co-morbidities such as asthma, the variation in hair growth rate among racial/ethnic groups or the method used to analyse hair cortisol.[37] Regarding the latter, high performance liquid chromatography or mass spectrometry (HPLC or MS) are more promising techniques for hair analysis due to its high sensitivity, little cross reactivity, and high reproducibility.[38] Yet, it carries a considerable higher cost compared to immunoassays. Ultimately, any study intent on investigating stress via the use of questionnaires and/or HCC must carefully consider the intrinsic subjective qualities of both, as recently argued to great detail in a recent scientific report.[39]

CONCLUSION

The concern around job related stress is an old one and a topic that is clearly sensitive within the healthcare profession given the gravity of its consequences. Unsurprisingly, the past few years have seen a noticeable rise in the number of investigations into specific factors that lead to job related stress in the healthcare system in an attempt to overcome its well-known harm. Its goal has been to gain as much insight into what triggers stress but, just as importantly, the demographics of those affected. This study provided one such evidence, by investigating HCC and PSS on a particular cohort of healthcare professionals in Saudi Arabia. This was demonstrated by the distinct outcomes seen in our data that, on the one hand replicated the broadly reported findings that stress is biased towards gender but at the same time revealed that healthcare professionals in KSA differ with other regions regarding HCC levels, when compared to non-healthcare. Thus the main conclusions from this pilot work are essentially two: firstly, to validate the tool of assaying hair cortisol as a simple yet essential tool to measure long-term stress and, secondly, a recommendation to both policy makers or managers of the different health institutions seeking to address job-related stress to avoid adopting the generalised findings from the literature but opt instead by necessity to develop a study paradigm that considers all the regional elements that shape the cohort of interest.

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